



Master's Thesis Ideas 2012

M.Sc. in Indoor Environmental and Energy Engineering

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M.Sc. in Indoor Environmental and Energy Engineering:

Master's Thesis Ideas 2012

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Per Heiselberg
Henrik Brohus
Peter V. Nielsen
Liu Li**

Aalborg University
Department of Civil Engineering
Indoor Environmental Engineering

DCE Latest News No. 033

M.Sc. in Indoor Environmental and Energy Engineering:

Master's Thesis Ideas 2012

by

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Per Heiselberg
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May 2012

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List of projects

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5. PH Ventilative Cooling of Residences
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9. RLJ Energibesparelser i forswarets bygninger
10. RLJ Emhætte og grundventilation i lejligheder
11. RLJ Udvendig kortslutning mellem fraluft og tilluft ved decentrale ventilationsanlæg

Altiflex: Reusable weather and fall protection system

Altiflex is an integrated weather and fall protection system to be used during building construction. It has a number of advantages compared to other weather protection systems.



The main benefits include

- Flexible modules - will fit any opening
- Protects against wind and moisture
- Good thermal insulation reduces heating cost
- Improves working conditions
- Protects against theft
- Reusable - no maintenance required
- Competitive compared to traditional solutions

The company Altiflex was founded in 2004 with the first installations in 2006. The system is patented in 30 countries, incl. EU, China and US. After four successful years on the Danish market products are now being promoted in selected international markets, but a main barrier is the lack of documentation of system benefits mainly the reductions in energy use for heating and improvement of airtightness.

The project will take its point of departure at a few building construction sites to measure the characteristics and performance of the Altiflex system compared to more traditional weather protection system. Secondly the focus will be on the development of a prediction method the company can use calculate the effect of the airtightness improvement and the expected reduction in energy use for heating by applying the system on a specific building project.

Dynamic Wall Systems

The project focuses on the analysis and development of concrete building construction elements, which can be actively used for transfer and storage of heat and air. In many buildings like offices, schools and other commercial buildings there is a cooling need during occupied hours and a heating need in nights and weekends. If heat during daytime could be stored in the building construction more efficiently and released during night-time, the energy use for heating and cooling could be reduced considerably or might even be eliminated.

In order to exploit concrete constructions elements more efficiently porous concrete materials should be developed that allow the transfer of air and thereby improves the heat transfer and storage capabilities. In order to maintain a high thermal capacity of the construction at acceptable temperature levels phase change materials should be integrated in the construction. Some ideas for the development of a porous concrete construction already exist, but there is a strong need for integration of PCM's in the construction and analysis of the structural and thermal performance. In order to transfer energy efficiently from the indoor environment to the concrete construction and vice versa air systems needs to be developed as well as the best way to integrate these systems into the building construction.



Description

The project will include the following main tasks:

Literature/State-of-the-Art study regarding passive cooling, thermal mass activation, phase change materials, porous concrete technology, modeling of heat and mass transfer in porous materials, modeling of phase change materials.

Development of ideas and concepts for potential technical solutions for application of porous concrete and phase change materials in building construction for passive cooling purposes.

Experimental characterization of thermal and structural performance of porous concrete and porous concrete in combination with phase change materials

Supervisors:

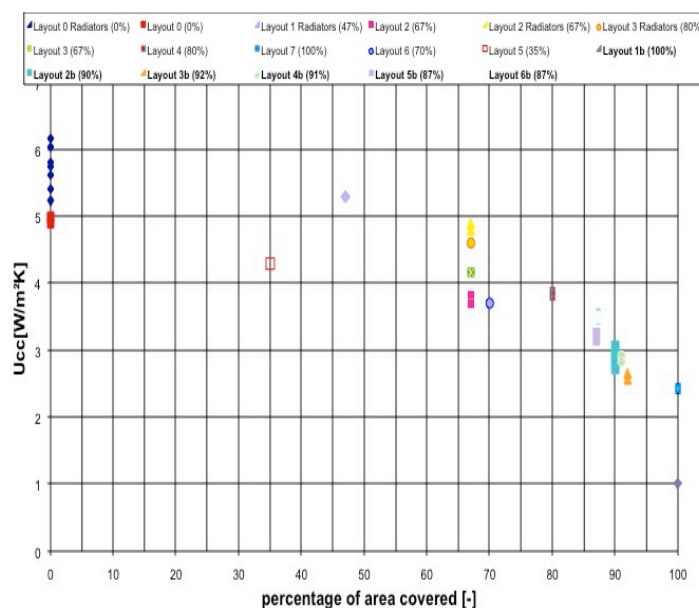
Prof. Per Heiselberg, Institut for Byggeri og Anlæg, Aalborg Universitet

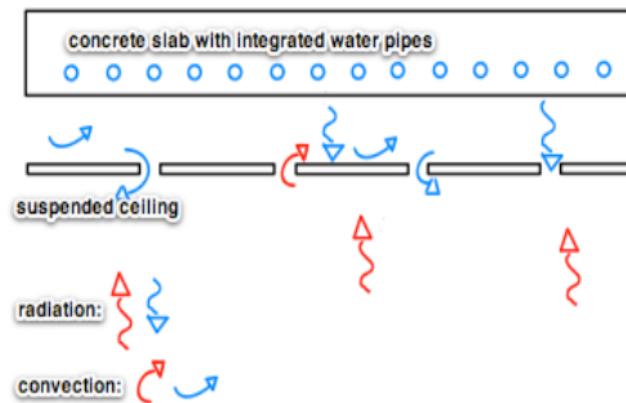
Lektor Eigil Sørensen, Institut for Byggeri og Anlæg, Aalborg Universitet

Monitoring and analysis of heating and cooling in new office building with TABS

Thermo active slabs (TABS) are a fairly new concept, which has recently been used in several office buildings. In short, TABS is pipes embedded in the concrete core of the floor decks. In the pipes, water at close to room temperature is circulated, which supplies heating or cooling to the building. In general both floor and ceiling surface are used to exchange heating and cooling with the room. Due to the large thermal mass and low temperature requirements it is ideal for supply from renewable energy sources. On the other hand, the control is somewhat more difficult than conventional heating and cooling systems.

One major issue for TABS to function thermally is that it requires that the room can "see" the concrete. Conversely, the acoustic conditions require a suspended ceiling to keep noise levels at an acceptable level. There is therefore a risk that the use of TABS is not possible due to acoustic requirements. A number of studies have shown that it is possible to only partly cover the ceiling to get both acceptable acoustic and thermal conditions. An extract of the monitoring results are shown below, where the mode of heat transfer is also sketched.





It can be seen that even a large covering percentage still gives a significant cooling from the ceiling.

COWI's new office building in Aalborg has been equipped with TABS and acoustic ceiling. The building is supplied with ground water cooling and district heating. The building is mechanically ventilated. For further information see the attached newspaper article.

The goal of the project will be to experimentally verify that the functionality of TABS in the building. In the project the student(s) will work with monitoring of the conditions in the building, both on the supply side and in the rooms. In the rooms it is interesting to see if there are any problems with draught from different covering percentages.

Further it is possible to do experimental work, where especially the risk of draught in naturally ventilated buildings combined with TABS should be examined. Here it is especially interesting to investigate different ventilation strategies to minimize the problems.

It is expected that the students are interested in both experimental and theoretical work, with the main focus on the experimental issues in the project.

The results from the project will be directly used by COWI to further advance the use of TABS in new very low energy office buildings.

Mæglere forventer fortsat prisfald

DANMARK: Fortsat faldende gennemsnitspriser og svage stigninger i salget. Så kort kan forventningerne til boligmarkedet i 2012 beskrives hos ejendoms-mæglerkæden EDC. Mere konkret forventes en stigning i salget på omkring 5 pct. og et nogenlunde tilsvarende fald i priserne set som et gennemsnit. -ll

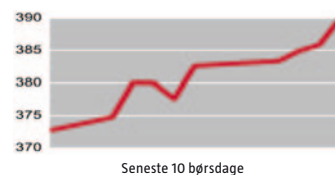
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Job&Erhverv

LØRDAG 31. december 2011 . www.nordjyske.dk

OMX-C20



Cowi-bygningen på Eternitgrunden i Aalborg er mest kendt for sine skæve linjer, men klimamæssigt er den også noget af en nyskabelse.

Arkivfoto

Køleslangerne sidder i lofterne

INDEKLIMA: Spæncom og Cowi har udviklet energibesparende kølesystem

Af Flemming Junker

flemming.junker@nordjyske.dk

AALBORG: Mens mange almindelige danskere bekymrer sig over varmeregnen, er det udgifterne til nedkøling, der fylder mest i moderne kontorhuse. Men det har betonelementfabrikken Spæncom og ingeniørfirmaet Cowi fundet en løsning på.

- Vi har udviklet en ny type betonelementer til etageadskillelser, hvor der er indstøbt slanger til kølevand, som cirkulerer og på den måde køler bygningen ned, forklarer marketingchef Per Bachmann fra Spæncom A/S, der har afdelinger i Aalborg, Kolding, Hedehusene, Vemmelev og Tune.

Han fortæller, at kontorbygninger udgør en særlig udfordring, hvad angår indeklimaet, fordi der er mange mennesker, computere, printere osv., der afgiver varme.

- Derfor er det faktisk et

større problem at køle en kontorbygning ned end at varme den op, og nedkølingen udgør også en større del af energiforbruget, end opvarmningen gør, nævner Per Bachmann.

Skæve linjer og ny teknologi

Spæncom har anvendt den nye type huldæk, der kaldes TermoMax, ved flere projekter, og i øjeblikket er man sammen med Cowi ved at opføre Cowis nye domicil i Aalborg, hvor der også er lagt køleslanger i etageadskillelserne.

Bygningen, der ligger på Eternitgrunden på hjørnet af Østre Allé og Sønderbro, er mest kendt for sine skæve linjer, der er trukket af kunstneren Marco Evaristti, men teknisk set er den altså også noget af en nyskabelse.

Bruger grundvand til kølingen

Projektleder på projektet Martin Nørkær Hansen fra Cowi forklarer, at normalt har man et køleanlæg til at

blæse kold luft ind gennem ventilationskanalerne i et kontorhus:

- Her i huset benyttes ventilationskanalerne alene til at hente frisk luft ind, så der er ikke udgifter til at køle denne luft ned. I stedet sørger køleslangerne i lofterne for at holde en passende behagelig temperatur i bygningen.

Martin Nørkær Hansen nævner, at det normalt vil være nødvendigt at køle vandet i huldækkene ned, inden det ledes ind i bygningen, men at det er billigere end at køle luften ned.

- Det giver generelt en energibesparelse, men i dette byggeri er vi gået et skridt videre, idet vi har mulighed for at udnytte grundvand til nedkølingen.

- Så hvor man normalt har et køleanlæg til vandkølingen, har vi i stedet en pumpe, som hiver grundvand op og sender det direkte ind i huldækkene. Når det har afgivet sin kølighed, sendes

det ned i grundvandslaget igen et andet sted, oplyser Martin Nørkær Hansen.

Kuldelager

Når kontorbygningen står færdig, vil det ikke være til at se, at indeklimaet styres på en helt anden måde end normalt. Det eneste, der kommer til at afsløre det, er lofter med særligt mange gitteråbninger, der skal sørge for, at kølingen fra huldækkene også kommer ned i lokalerne.

Nærmere bestemt fungerer elementerne som et kuldelager, idet de køles ned om natten ved hjælp af det kolde vand, der pumpes rundt i de indstøbte rør.

I dagtimerne trækker de nedkølede betonelementer overskudsvarme ud af rumluften, der på den måde holdes på et passende niveau uden brug af et dyrt og energikrævende anlæg til aircondition.

Det første projekt, hvor TermoMax-elementerne



De mange gitterriste i lofterne afslører, at kølingen i kontorbygningen kommer ovenfra.

Foto: Thomas Hansen



De hvide kunststofslanger støbes ind i huldækkene under produktionen. Senere kobles de sammen, så kølevandet kan cirkulere i lofterne på en bygning.

blev brugt, var ved opførelsen af en ny bygning til Midelfart Sparekasse, der stod klar sidste år.

Siden da har Danmarks Tekniske Universitet foretaget målinger af bygningens indeklima og energiforbrug, og på den baggrund konkluderer centerleder og professor Bjarne W. Olesen, der har været projektleder på undersøgelsen, at der med anvendelsen af TermoMax-pladerne er opnået meget gode resultater:

- De har medført et behageligt indeklima og dermed gode arbejdsforhold. Andre fordele er en forbedring af energieffektiviteten på køleanlægget, udtaler Bjarne W. Olesen.

Spæncom har da også store forventninger til det nye produkt:

- Der kommer hele tiden nye energikrav fra myndighederne, så en løsning som vores kan hjælpe en bygherre med at opfylde disse krav, siger Per Bachmann.

Ventilation window with solar shading/ night blind

Background

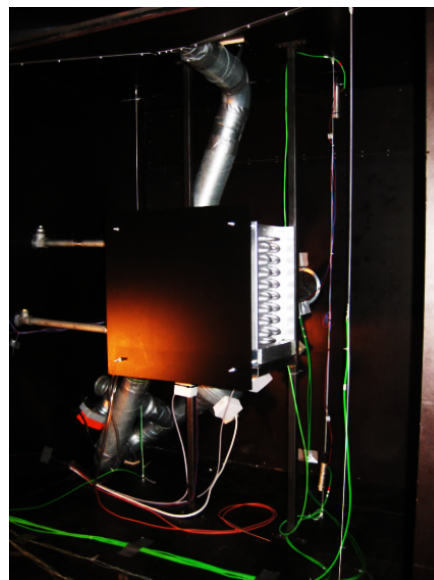
The CLIMAWIN consortium, a group of European SME manufacturers and suppliers of windows, aims to address a major market opportunity regarding energy efficient fenestration systems for renovation of residential buildings. Specifically, the consortium aims at developing a novel high-performance window with a natural ventilation system and an insulating night blind. The window should incorporate movable openings (vents) on the lower part of the frame on the outside and on the upper part on the inside in order to permit air intake to control IAQ, temperature and humidity, thus contributing to optimal living conditions. The window should also consist of a frame with mounted insulated glass panes and an interior (interpane) solar shade/night blind.

Objective

The first objective of the project is based on laboratory experiments to document the performance of the ventilation system for the window and to optimize its performance. The second objective is to document the performance of a combined solar shading and night blind. Finally, to verify a developed tool to predict the performance of the window including both ventilation and solar shading/night blind and suggest model improvements.

Project description

The first task is to further develop and optimize the window ventilation system. Based on laboratory measurements it includes further development of the ventilation grille, determination of the optimum size of the ventilation gap and determination of the optimum location of the solar shading/blind. The ventilation grilles should be able to provide the necessary air flow rate to cool the ventilation gap in the summer period and be able to control the inlet flow rate according to the needs of the room.



The second task is the development and documentation of the performance of a new window element that combines solar shading in daytime and thermal insulation by a night blind during night time. This also includes optimization of the energy performance of the window system by analysis and selection of glazing and window frame. This will be done by numerical methods to analyze the performance of the combined solar shading/night blind component depending on different component characteristics like material type and geometry, surface reflection, surface absorption,

perforation percentage, etc. Based on these analyses the performance requirements for a combined solar shading/night blind will be determined and 2-3 possible solutions suggested and tested.

Finally a developed tool for prediction of window performance will be verified and improvements suggested.

Project partners.

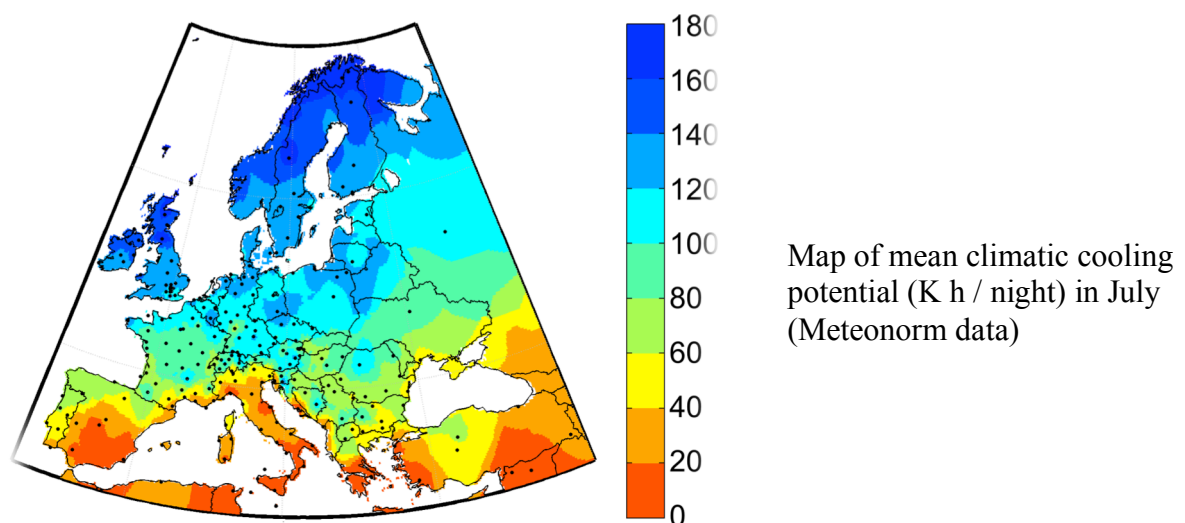
HORN Vinduer Aps (DK), Solearth, (EI)

Supervisors: Per Heiselberg, Hicham Johra

Ventilative Cooling of Residences

The current development in building energy efficiency towards nearly-zero energy buildings represents a number of new challenges to building design and construction. One of the major challenges is the increased need for cooling present in these highly insulated and airtight buildings, which is not only present in the summer period but also in the shoulder seasons. In most post-occupancy studies of high performance buildings in European countries elevated temperature levels is the most reported problem, especially in residences. Designers underestimate the cooling need and often use too simplified design methodologies to assess the risk of overheating.

Ventilation can be an attractive and energy efficient solution, as it is already present in most buildings and because it can both remove excess heat gains as well as increase air velocities and thereby widen the thermal comfort range. As cooling becomes a need almost all year around the possibilities of utilizing the free cooling potential of low temperature outdoor air increases considerably. This leads to the following scope for the project: “How and when can strategies for increased ventilation reduce the cooling load while maintaining good environmental quality?”



Energy efficient use of ventilative cooling (air-borne systems) in high performance buildings face several challenges to become the preferred solution. This leads to the following topics that could be included in the project:

- Mapping of existing ventilation systems and technologies, existing legislation, case studies and typical comfort control solutions.
- Establish methodologies for analysis of ventilative cooling systems from the perspective of utilization of the free cooling potential of outdoor air assisted by other natural sinks, exploitation of the building thermal mass and other passive cooling measures. Emphasis should be on the evaluation and development of methodologies and tools suitable for design purposes as well as for integration in energy performance calculation methods (BE10).
- Extend the boundaries of existing ventilation system solution and develop new flexible and reliable ventilative cooling solutions that can create

comfortable conditions under both “large flow rate/high temperature” and “small flow rate/low temperature” conditions, i.e. able to provide comfort under a wide range of climatic conditions.

- Development of advanced control strategies providing optimal cooling (optimise energy efficiency) and comfort.

Project partners: Velux A/S

Supervisor: Per Heiselberg, Rasmus Lund Jensen



Simplified Building Comfort Models

- *Increased focus on reduced energy consumption in buildings may lead to deteriorated thermal comfort and IAQ*
- *This fact is considered in new building regulations demanding further documentation as to indoor climate*
- *Simplified building comfort models are strongly requested by designers and authorities to enable efficient documentation*
- *Is it possible to make a simplified model that provides results at a reasonably high level of accuracy and quality?*

- Long Master's Thesis (9th – 10th semester) for 1 – 3 students
- In collaboration with Danish Building Research Institute (SBI)
- Supervisors: Henrik Brohus and Rasmus L. Jensen

The purpose is to develop and evaluate one or more simplified building comfort models. The work will examine existing advanced and simplified building simulation models and evaluate pros and cons as to indoor climate simulation. The models should respond to the request for documentation in the new building regulations and consider limitations by comparisons with measurements and uncertainty calculations.

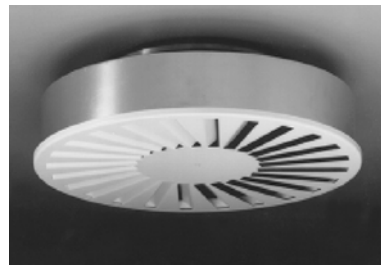
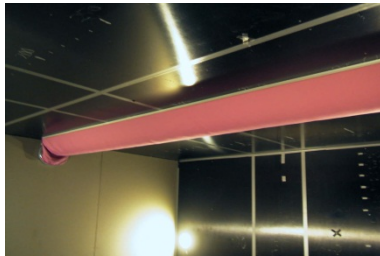


Diffuse Ceiling Inlet

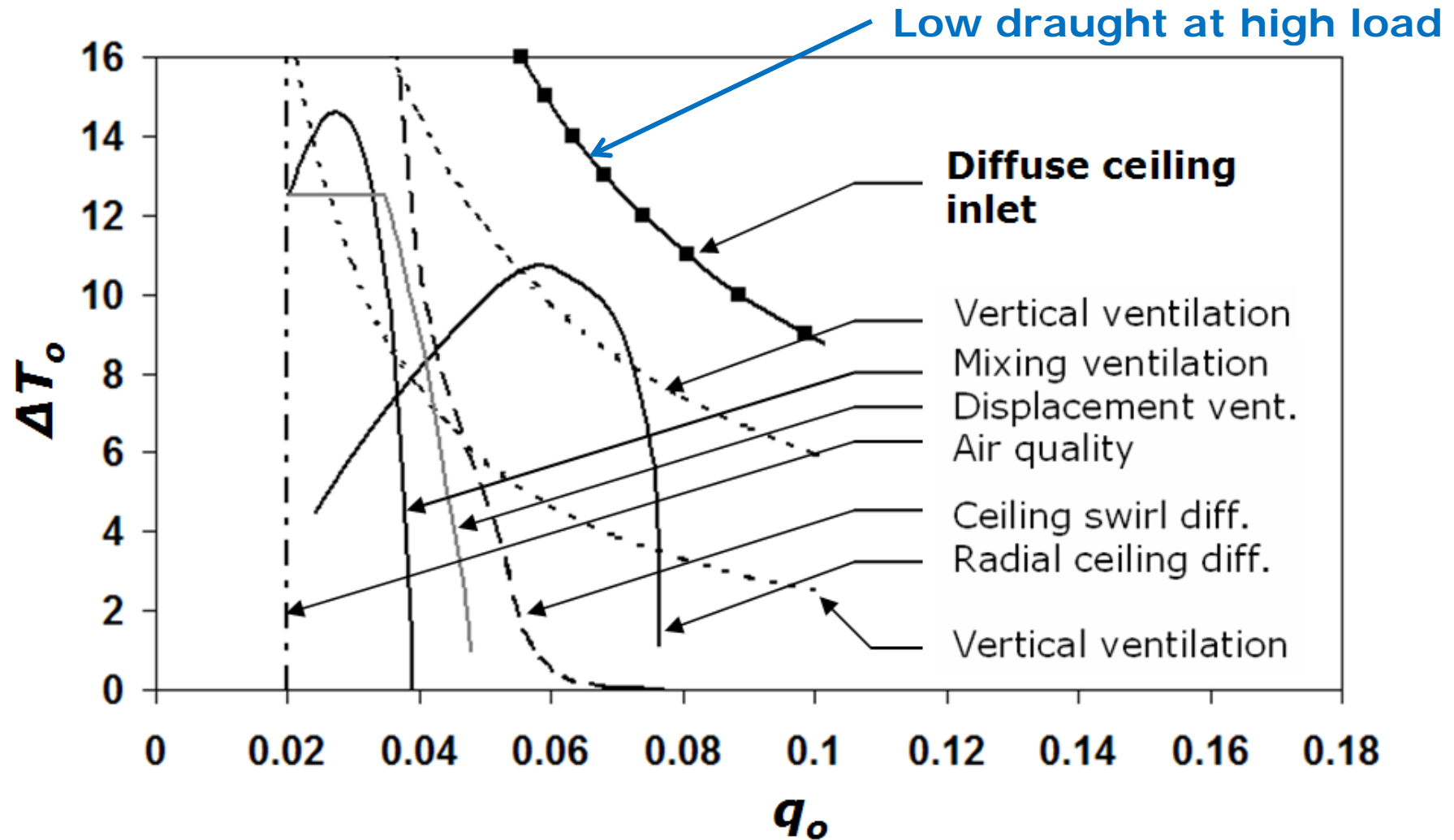
Li Liu
Peter V. Nielsen
Rasmus L. Jensen

Six Different Air Distribution Systems

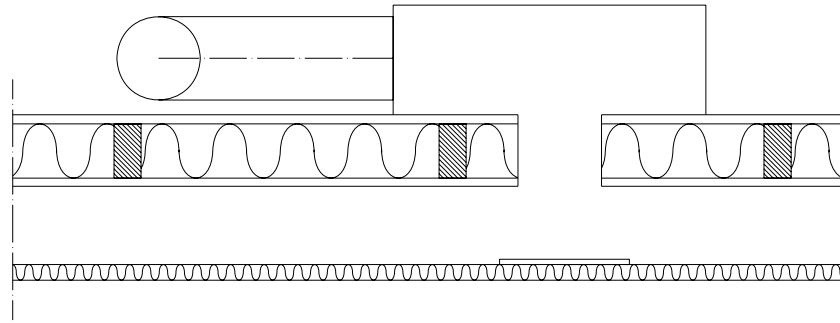
-Tested in the same geometry and with the same load



$q_o - \Delta T_o$ Design Chart



Types of Diffuser, for example:



A Building with Diffuse Ceiling Inlet



Widex new office and
production building

20.000 m² with
diffuse inlet

Peter V. Nielsen, Aalborg University



This Year's Project: The National Museum in Oslo

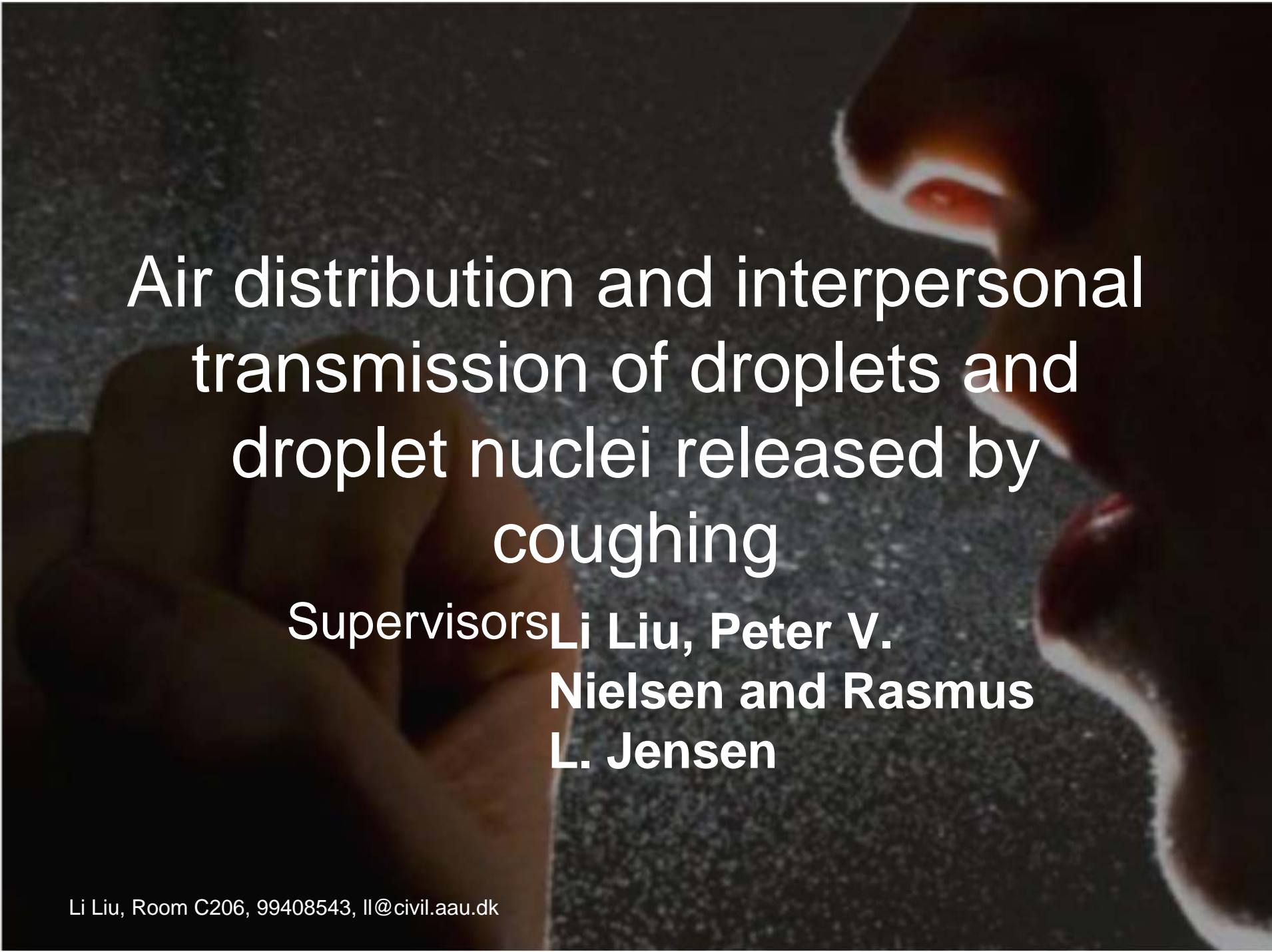
- Supply through the ceiling material (No visible openings)



- The ceiling is built on location
- Study of supply details and supply strategy

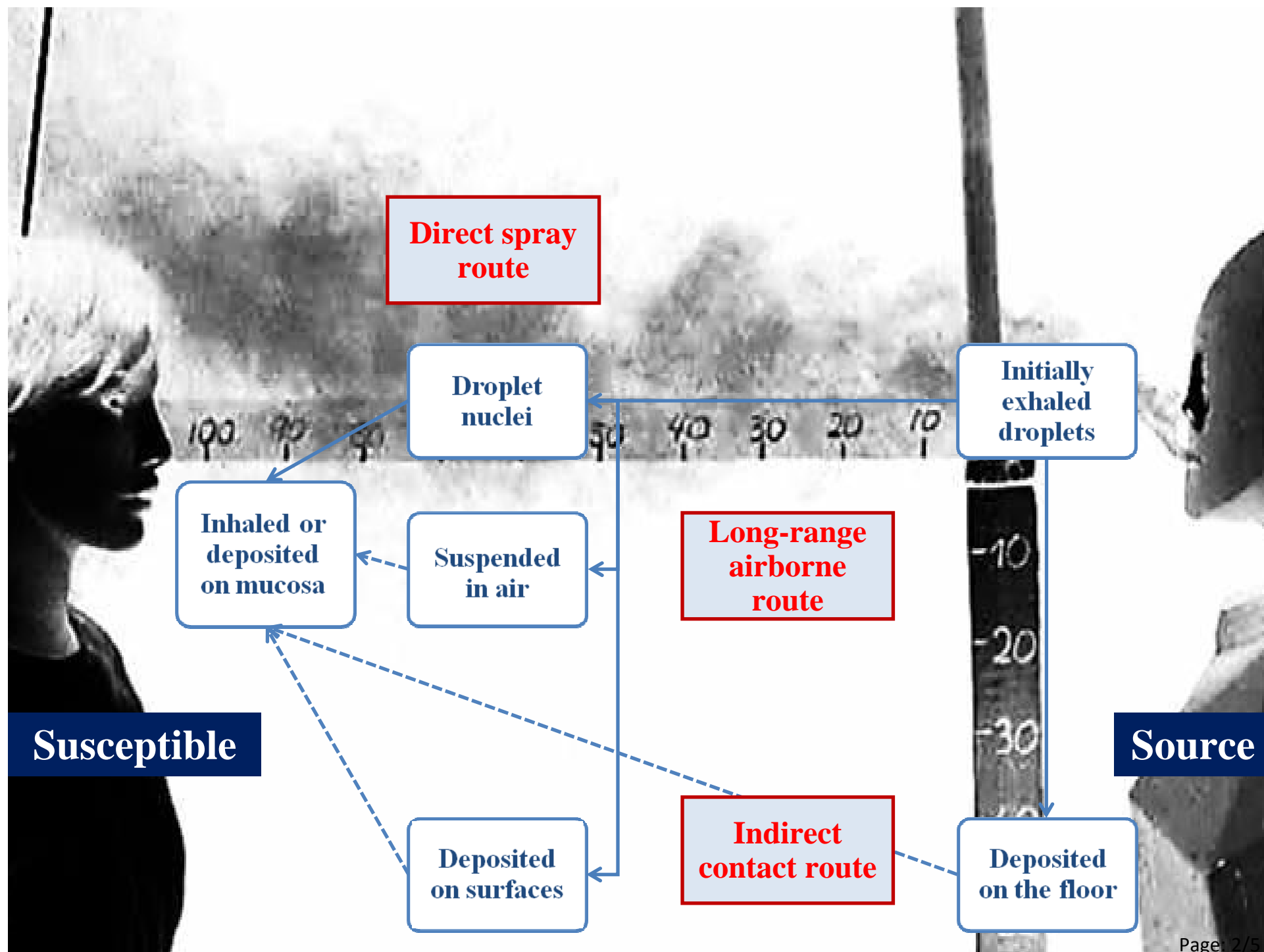
This Year's Project: The National Museum in Oslo

- Large room height
- Study of cooling and heating situations
(draught, temperature gradients, air quality)
- Study of room air stability

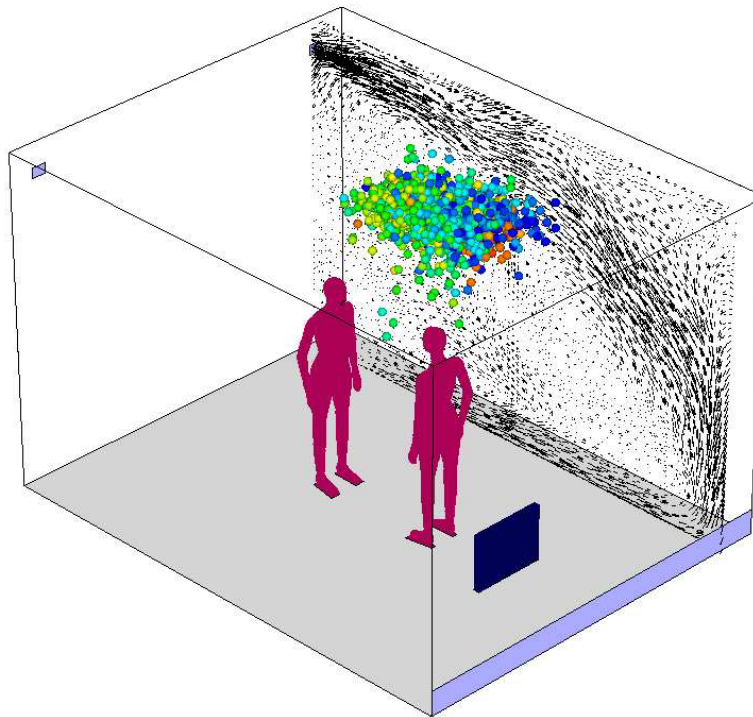


Air distribution and interpersonal transmission of droplets and droplet nuclei released by coughing

Supervisors **Li Liu, Peter V. Nielsen and Rasmus L. Jensen**



In this study, several ventilation modes could be tested to seek an effective intervention, including full-scale measurements for **downward ventilation**, CFD simulations for **mixing ventilation**, **displacement ventilation**, and **under-floor air distribution** ventilation, combining with **personalized ventilation**.



Air distribution has a considerable impact on interpersonal transport of droplets and droplet nuclei

Tools

Full scale room and manikins

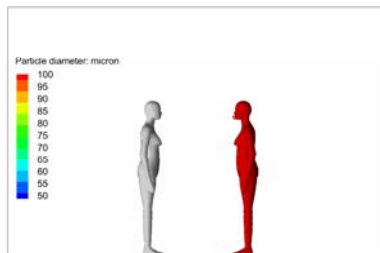


Artificial lung for breathing and coughing



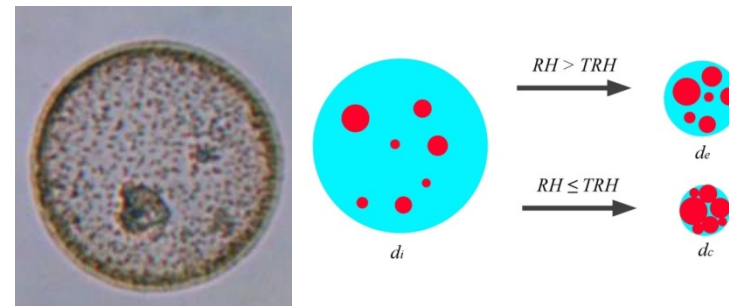
CFD

Time: 4.1 second

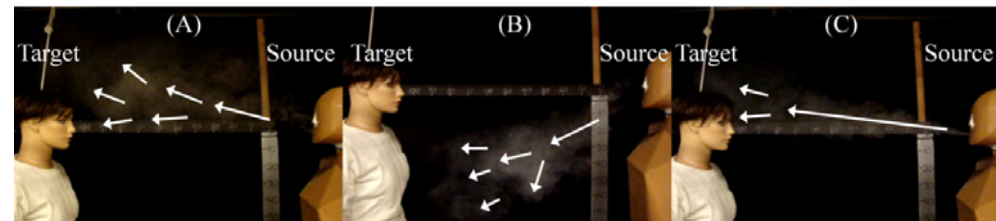


Knowledge

Knowledge of droplets



Knowledge of microenvironment



Knowledge of air distribution



Objective:

An effective ventilation system to minimize the transmission of droplets and droplet nuclei

Ventilation and interpersonal transmission of droplets and droplet nuclei

- Transmission routes
- Droplet evaporation and dispersion
- Human coughing features
- Airflows and their interaction in the microenvironment
- Air distribution patterns giving high protection
- Full-scale experiments with particles/droplets
- CFD

Energibesparelser i forsvarets bygninger

Introduktion

Forsvarets Bygningsetablisement er i øjeblikket ved at gennemføre projektet: "Den Intelligente Bygning i Forsvaret", som blandt andet omhandler muligheden for automatisk energibesparelse. Ideen med automatisk energibesparelse er, at koble informationer fra allerede eksisterende systemer til et overordnet styringssystem. Eksempler på dette kunne være:

Alarmsystemet registrerer at et vindue er åbnet. Hvis ikke vinduet er lukket efter 5min lukker klimasystemet for termostaten ved radiatoren nedenfor vinduet.

Kalendersystemet ved at der ikke er nogen personer på arbejde på et bestemt kontor. Der bliver automatisk slukket for computere, lys og ventilation.

I en indkvarteringsbygning er der ikke registreret nogen gæster i bookingsystemet. Lys og ventilation slukkes og der skrues ned for fremløbstemperaturen fra fyret.

Formål

Som indledning til projektet ønskes det at få undersøgt hvor stort besparelspotentiale der er indeholdt i at indføre automatisk energibesparelse. Til dette formål skal der opbygges en dynamisk modulær model for tre konkrete bygninger. Modellen skal give mulighed for at sammenkoble forskellige typer af rum f.eks. kontor, toilet, gang, soverum etc., så der opnås en "plug and play" opbygning af en bygning med tilhørende energiforbrugende installationer f.eks. lys, varme, computere o.l..

Den opbyggede model skal operere med et antal input, så selve brugsmønstret for bygningen kan simuleres. Dette kan eksempelvis være varierende udetemperatur, nogle personer glemmer at slukke lys/PC når de går hjem mens andre husker det, nogle folk regulerer på ventilationssystemet andre åbner/lukker vinduer etc..

Ovenstående skal resultere i en model der gør det muligt at simulere det samlede energiforbrug for en bygning.

Parallelt med brugsmønstre for en bygning skal der udvikles et styringsmodul hvor der kan implementeres forbrugsregler for bygningen som beskrevet i introduktionen. Det skal derved være muligt at sammenligne det totale energiforbrug for en bygning med og uden intelligent energistyring.

Emhætte og grundventilation i lejligheder

Baggrund: Der er krav om mekanisk ventilation i lejligheder, og der er i stigende grad stramme krav til energiforbruget. Boliger er i stigende grad tætte, specielt efter en energirenovering. Vi kan forudse, der bliver tale om virkelig mange renoveringer af lejligheder i de kommende år.

Problem: Hvordan koordinerer man udsugning gennem emhætten i køkkenet med den i øvrig balancerede ventilation med varmegenvinding? En emhætte udsuger store luftmængder i forhold til behovet for grundventilation ifølge BR. Så hvad gør man med ventilationsanlægget, mens emhætten kører? Skal der være tale om to separate systemer, eller kan de kombineres? Man kan pga. bygningens tæthed ikke længere regne med, at infiltration udligner en eventuel ubalance, i hvert fald ikke uden gener for beboerne. Der skal derfor tages højde for problemstillingen i anlægget og i styringen.

Anlægsmæssige muligheder:

1. Suge al udsugningsluft fra emhætten gennem ventilationsanlægget, hvorved man genvinder varmen til erstatningsluften. Der er besparelse i anlægskostninger i forhold til at lade emhætte være et selvstændigt system. Problemet er, at der kan være fedt i udsugningsluften. Et fedtfilter er ikke 100% effektivt. Vil man tilsmudse ventilationsanlægget med dette? Det giver en masse vedligeholdelse med filterskift og rensning. Hvad sker der så, når det ikke vedligeholdes tilstrækkeligt?
2. Lade emhætten føre udsugningsluft direkte til det fri med egen ventilator.
 - a. Erstatningsluft direkte fra det fri gennem en overtryksventil. Problem: Varmetab og trækgener.
 - b. Erstatningsluft gennem ventilationsanlægget, som slukker for udsugningen imens. Hvis der ikke skal være trækgener, skal der installeres en ret stor eftervarmeplade. Energita, desuden anlægskostninger.

Projektets indhold:

Der er behov for at analysere de anlægsmæssige, energimæssige, og komfortmæssige konsekvenser af forskellige løsninger.

Forslag til innovative tiltag, der kan afhjælpe problemerne:

1. Emhætte, hvor kold erstatningsluft tilføres ved "Aaberg-princippet", hvilket eventuelt kan øge emhættens effektivitet, dermed mindske luftmængden, desuden (måske) tilføre friskluft trækfrit. Men der er energimæssige konsekvenser.
2. Effektiv fjernelse af fedt og urenheder i luft fra emhætte. Cyklon? Elektrostatisk filter? Luftvasker?? Dermed opnår man at kunne bruge det almindelige ventilationsanlæg, og mindsker varmetabet.

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Udvendig kortslutning mellem fraluft og tilluft ved decentrale ventilationsanlæg.

Stadig stigende krav til energieffektivitet i bygninger har betydet en øget fokus på decentral ventilation, idet denne form for ventilation giver mulighed for store besparelser af elektricitet til transport af luft. Årsagen er kort transportvej og dermed lille trykfald.

Denne løsning har imidlertid et indbygget problem, idet der er kort afstand mellem afkast- og indblæsningsåbninger i facade eller på tag. Det giver en risiko for, at dele af afkastluften suges tilbage i friskluftindtaget i mere eller mindre ufortyndet tilstand. Hvis kortslutningen sker i samme rum, betyder dette en ringere effektivitet og dermed enten energispild eller ringere luftkvalitet, evt. begge dele. Hvis kortslutning sker mellem forskellige rum kan det give anledning til deciderede lugtgener, eller i værste fald transmission af sundhedsskadelige stoffer eller smitsomme, luftbårne bakterier eller virus.

Der mangler systematiske undersøgelser af, hvornår dette fænomen vil optræde, og i hvilket omfang. Desuden er der et stort potentiale for at komme med innovative løsningsforslag. Især er det interessant at finde løsninger, der er arkitektonisk acceptable, hvilket i praksis nok vil betyde, at man kan skjule indtag og afkast i facadeløsninger.



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